FIG.1

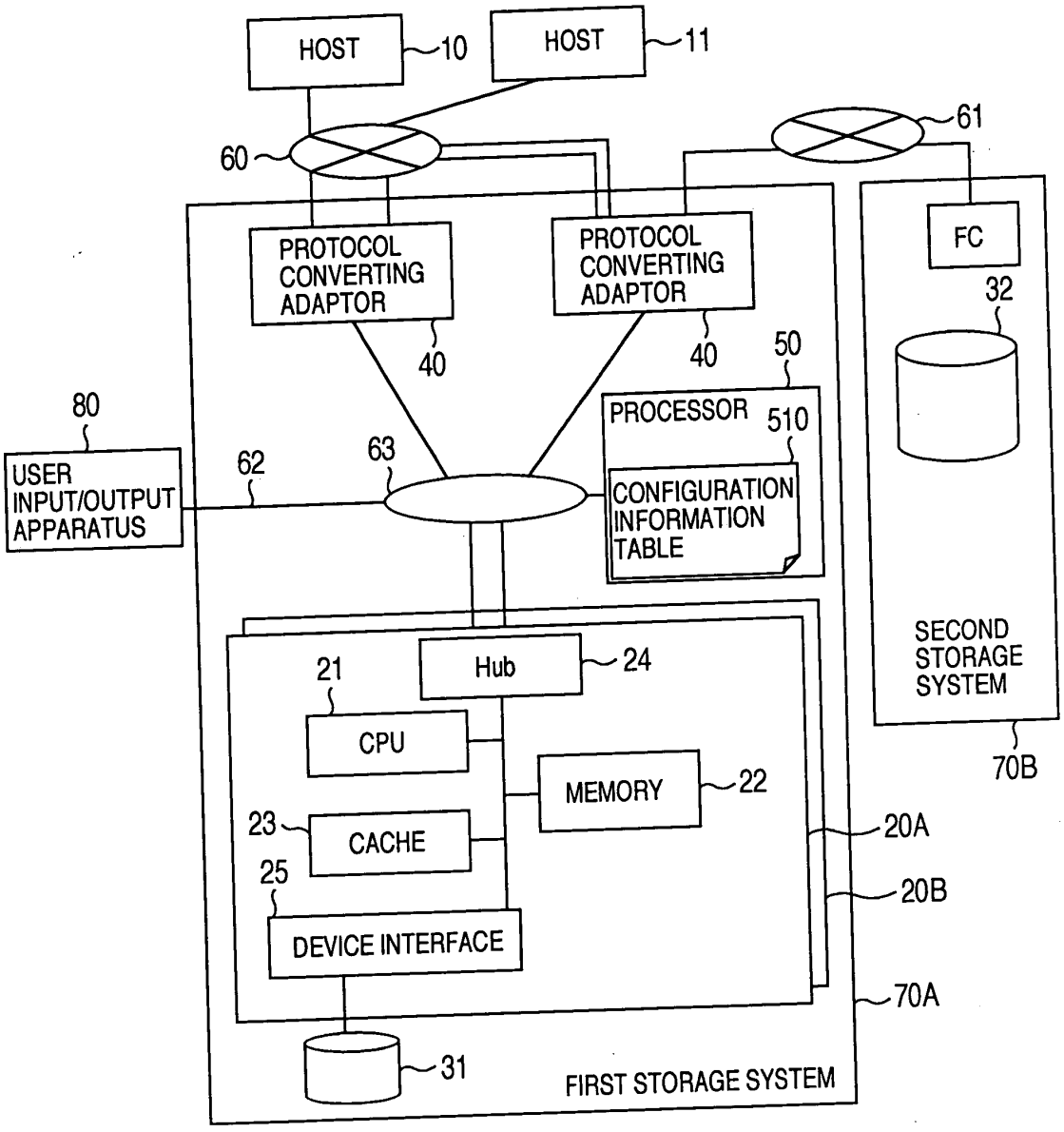

HOST
10
HOST
11
60
61
PROTOCOL CONVERTING ADAPTOR
40
PROTOCOL CONVERTING ADAPTOR
40
50
PROCESSOR
510
CONFIGURATION INFORMATION TABLE
80
USER INPUT/OUTPUT APPARATUS
62
63
FC
32
SECOND STORAGE SYSTEM
70B
21
Hub
24
CPU
MEMORY
22
23
CACHE
25
DEVICE INTERFACE
20A
20B
70A
31
FIRST STORAGE SYSTEM

FIG.2

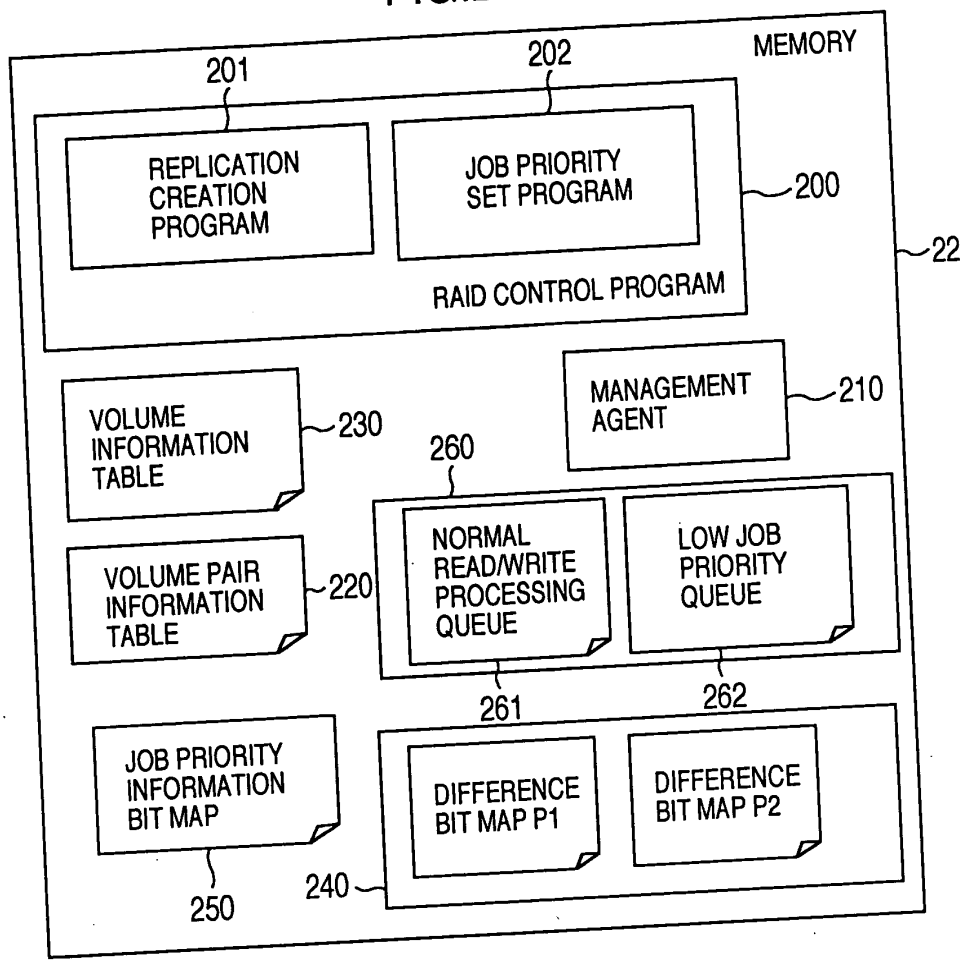

MEMORY
201
202
REPLICATION CREATION PROGRAM
JOB PRIORITY SET PROGRAM
200
RAID CONTROL PROGRAM
22
VOLUME INFORMATION TABLE
230
MANAGEMENT AGENT
210
260
VOLUME PAIR INFORMATION TABLE
220
NORMAL READ/WRITE PROCESSING QUEUE
LOW JOB PRIORITY QUEUE
261
262
JOB PRIORITY INFORMATION BIT MAP
DIFFERENCE BIT MAP P1
DIFFERENCE BIT MAP P2
250
240

FIG.3

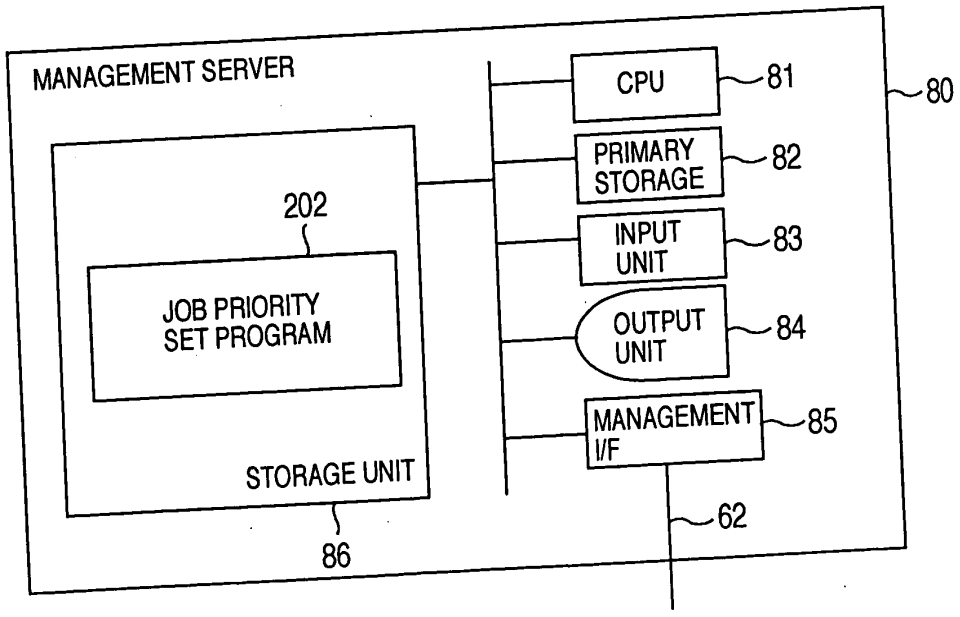

MANAGEMENT SERVER
CPU
81
80
PRIMARY STORAGE
82
202
INPUT UNIT
83
JOB PRIORITY SET PROGRAM
OUTPUT UNIT
84
MANAGEMENT I/F
85
STORAGE UNIT
62
86

FIG.4

220

PAIR NO.	MAIN VOLUME NO.	SECONDARY VOLUME INFORMATION			PAIR STATUS
		VIRTUALIZE	REAL DATA STORAGE		
		VOLUME NO.	STORAGE CONTROL UNIT NO.	VOLUME NO.	
0	100	200			Pair
1	110	210	2	120	Pair
2	120	220			Split
3	130	230	3	260	Pair
4	140	240			Split
221	222	223	224	225	226

FIG.5

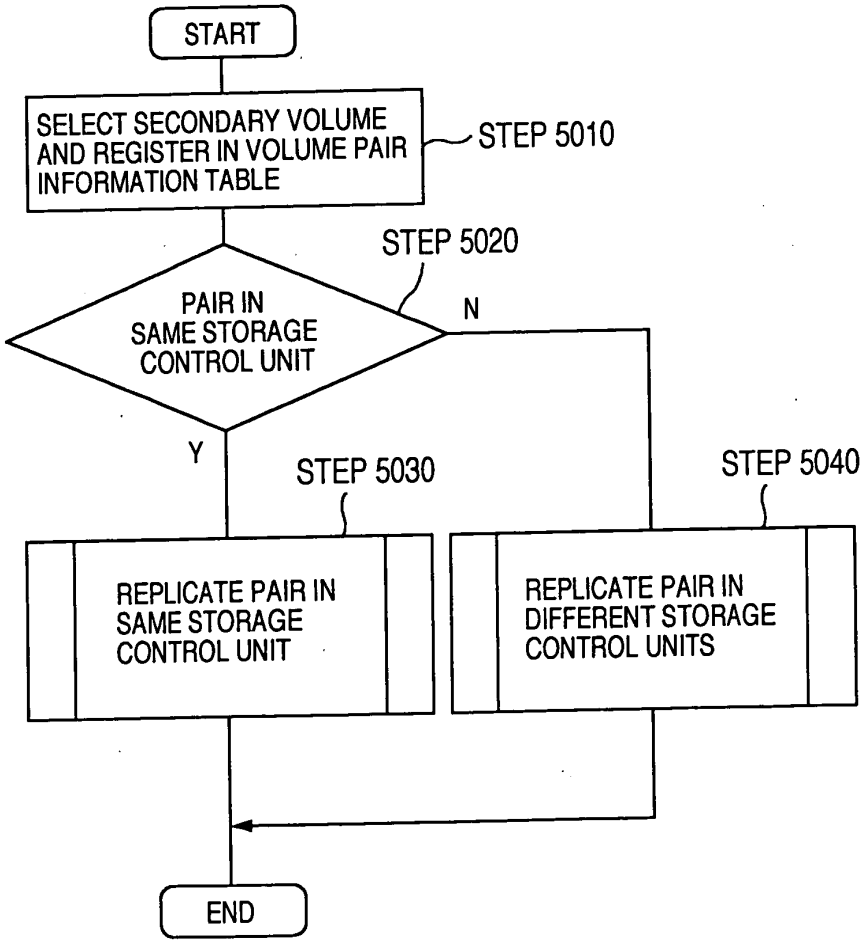


FIG.6

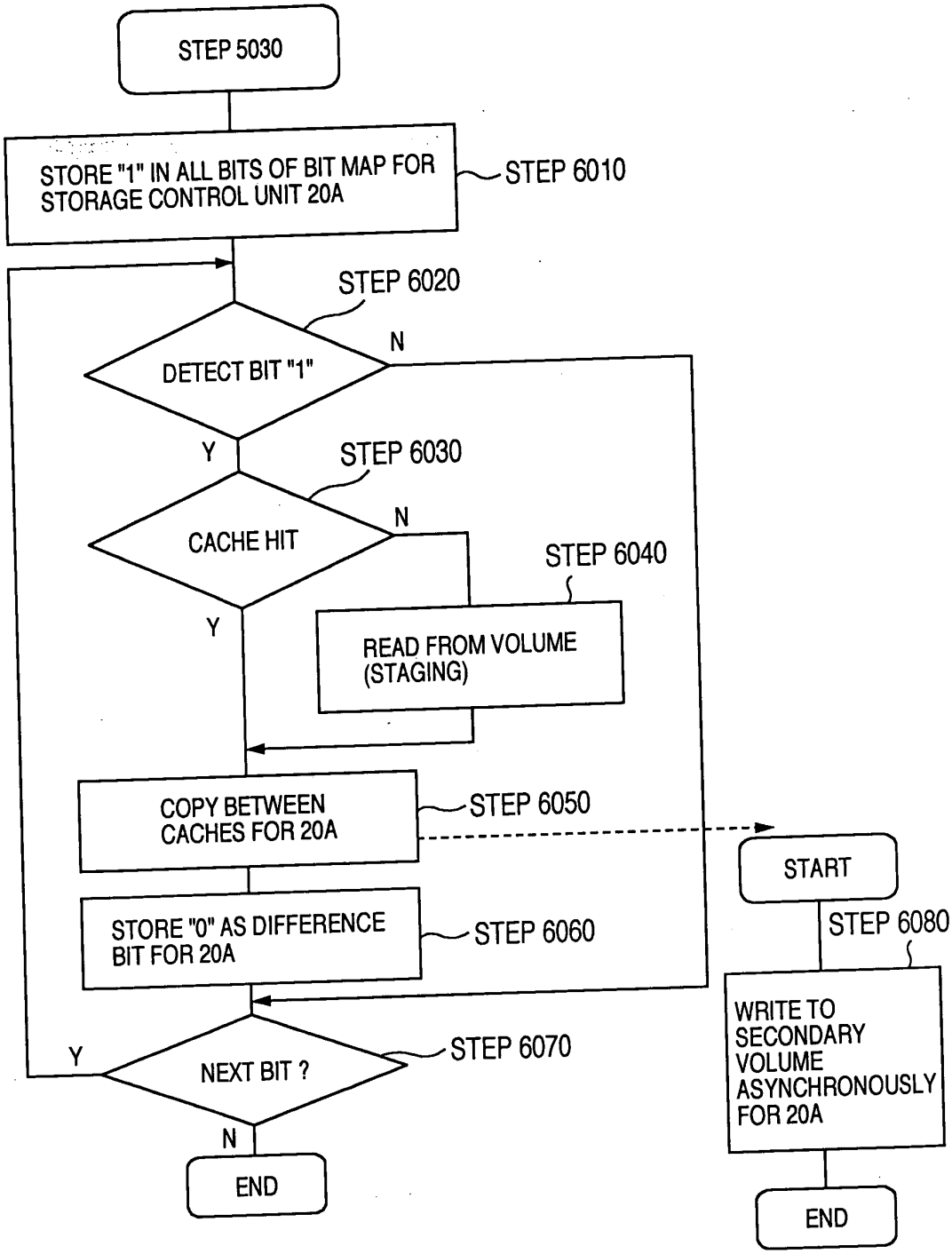

STEP 5030
STORE "1" IN ALL BITS OF BIT MAP FOR STORAGE CONTROL UNIT 20A
STEP 6010
STEP 6020
DETECT BIT "1"
N
Y
STEP 6030
CACHE HIT
N
Y
STEP 6040
READ FROM VOLUME (STAGING)
COPY BETWEEN CACHES FOR 20A
STEP 6050
STORE "0" AS DIFFERENCE BIT FOR 20A
STEP 6060
NEXT BIT ?
STEP 6070
Y
N
END
START
STEP 6080
WRITE TO SECONDARY VOLUME ASYNCHRONOUSLY FOR 20A
END

FIG.7

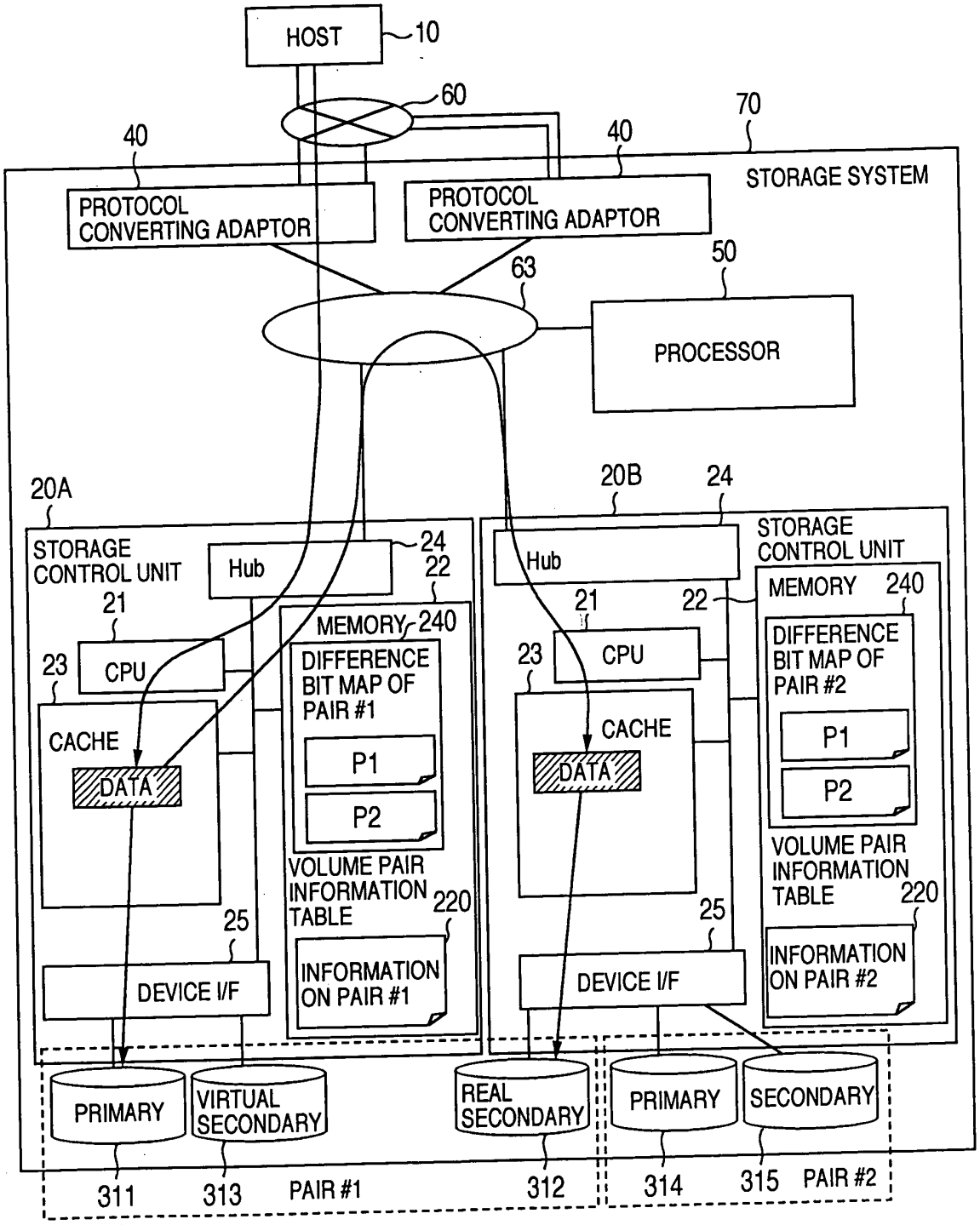

HOST
10
60
70
40
40
STORAGE SYSTEM
PROTOCOL CONVERTING ADAPTOR
PROTOCOL CONVERTING ADAPTOR
63
50
PROCESSOR
20A
20B
24
STORAGE CONTROL UNIT
Hub
24
22
21
MEMORY
240
23
CPU
DIFFERENCE BIT MAP OF PAIR #1
CACHE
DATA
P1
P2
VOLUME PAIR INFORMATION TABLE
220
25
DEVICE I/F
INFORMATION ON PAIR #1
Hub
STORAGE CONTROL UNIT
MEMORY
240
21
22
23
CPU
DIFFERENCE BIT MAP OF PAIR #2
CACHE
DATA
P1
P2
VOLUME PAIR INFORMATION TABLE
220
25
DEVICE I/F
INFORMATION ON PAIR #2
PRIMARY
VIRTUAL SECONDARY
REAL SECONDARY
PRIMARY
SECONDARY
311
313
PAIR #1
312
314
315
PAIR #2

FIG.8

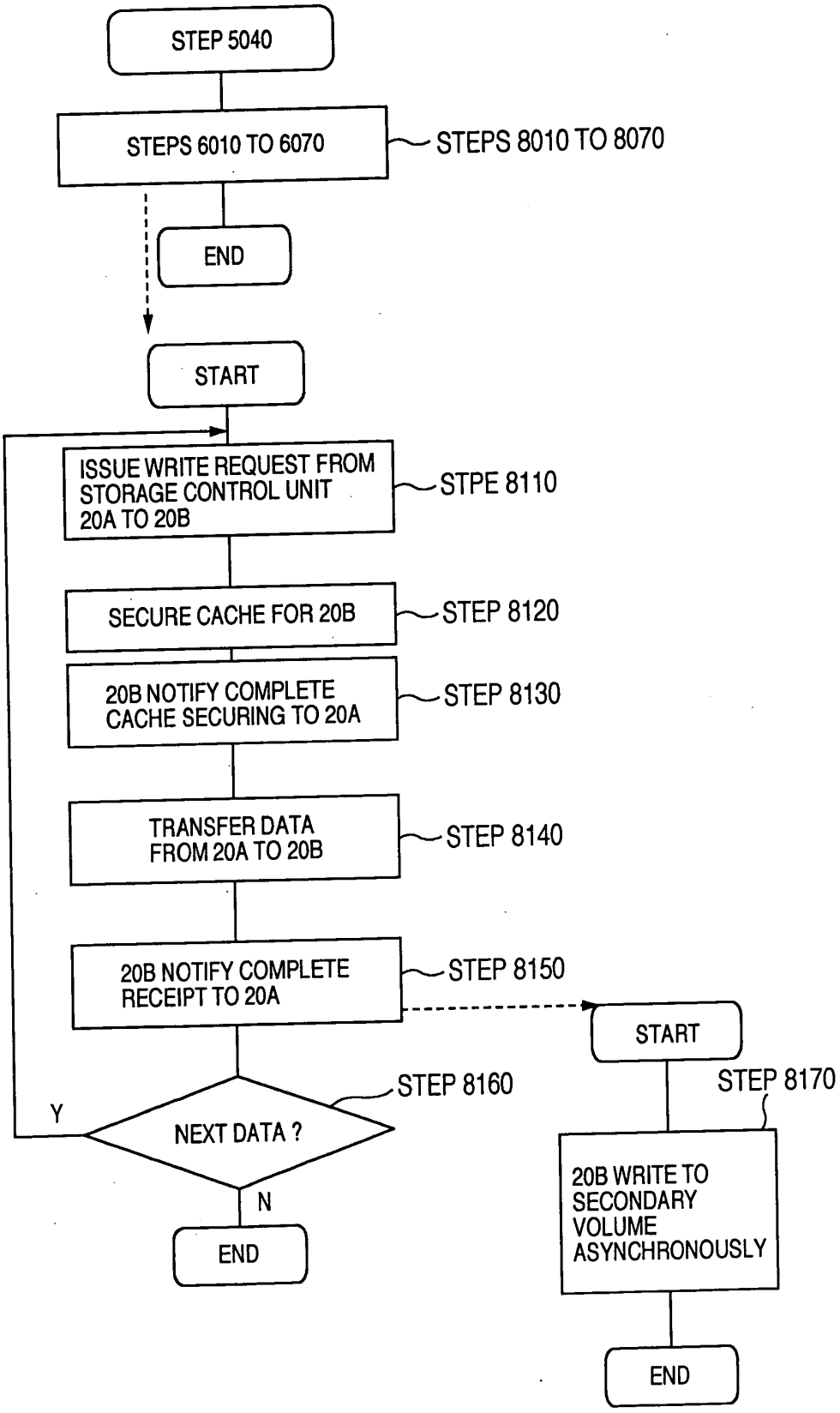

STEP 5040
STEPS 6010 TO 6070
STEPS 8010 TO 8070
END
START
ISSUE WRITE REQUEST FROM STORAGE CONTROL UNIT 20A TO 20B
STPE 8110
SECURE CACHE FOR 20B
STEP 8120
20B NOTIFY COMPLETE CACHE SECURING TO 20A
STEP 8130
TRANSFER DATA FROM 20A TO 20B
STEP 8140
20B NOTIFY COMPLETE RECEIPT TO 20A
STEP 8150
START
STEP 8160
STEP 8170
Y
NEXT DATA ?
N
20B WRITE TO SECONDARY VOLUME ASYNCHRONOUSLY
END
END

FIG.9

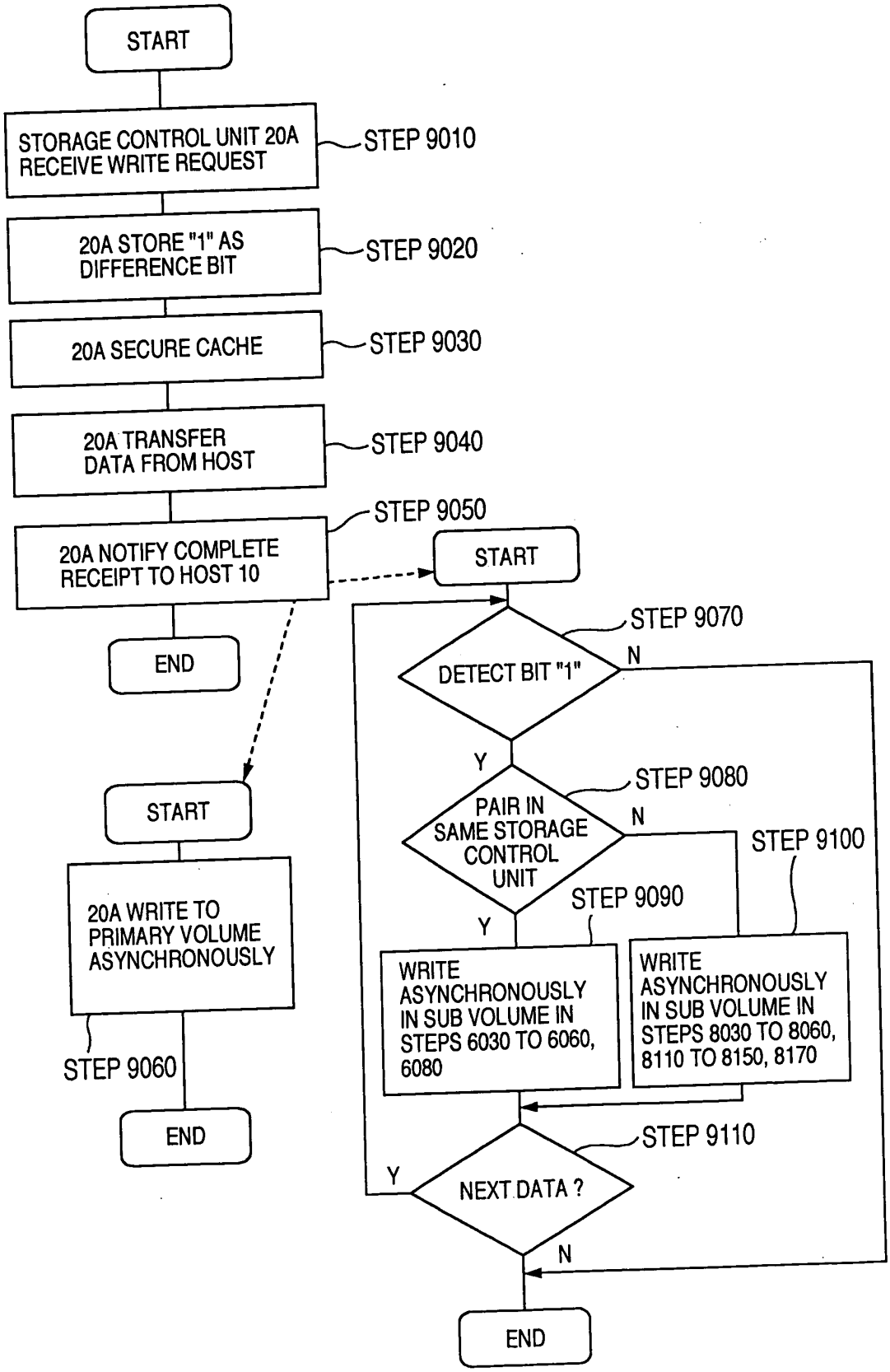

START
STORAGE CONTROL UNIT 20A RECEIVE WRITE REQUEST
STEP 9010
20A STORE "1" AS DIFFERENCE BIT
STEP 9020
20A SECURE CACHE
STEP 9030
20A TRANSFER DATA FROM HOST
STEP 9040
20A NOTIFY COMPLETE RECEIPT TO HOST 10
STEP 9050
END
START
20A WRITE TO PRIMARY VOLUME ASYNCHRONOUSLY
STEP 9060
END
START
STEP 9070
DETECT BIT "1"
N
Y
STEP 9080
PAIR IN SAME STORAGE CONTROL UNIT
N
Y
STEP 9090
STEP 9100
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 6030 TO 6060, 6080
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 8030 TO 8060, 8110 TO 8150, 8170
STEP 9110
NEXT DATA ?
Y
N
END

FIG.10

230

VOLUME NO.	PRIMARY/ SECONDARY	MATING VOLUME INFORMATION			VOLUME OCCUPIED
		SUB VOLUME OR VIRTUALIZE	REAL VOLUME INFORMATION		
			STORAGE CONTROL UNIT NO.	VOLUME NO.	
0	PRIMARY	1024	1	20	OCCUPIED
0	PRIMARY	158	—	—	OCCUPIED
0	PRIMARY	1025	1	426	OCCUPIED
1	SECONDARY		3	3783	OCCUPIED

231 232 233 234 235 236

FIG.11

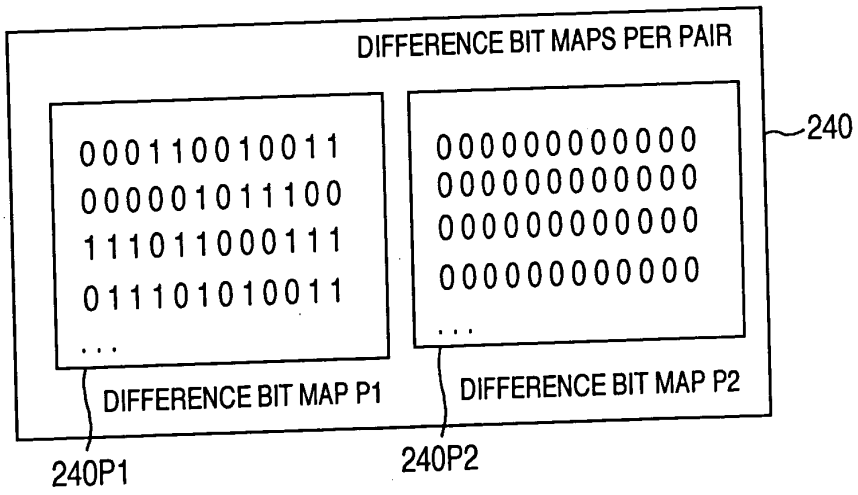


FIG.12

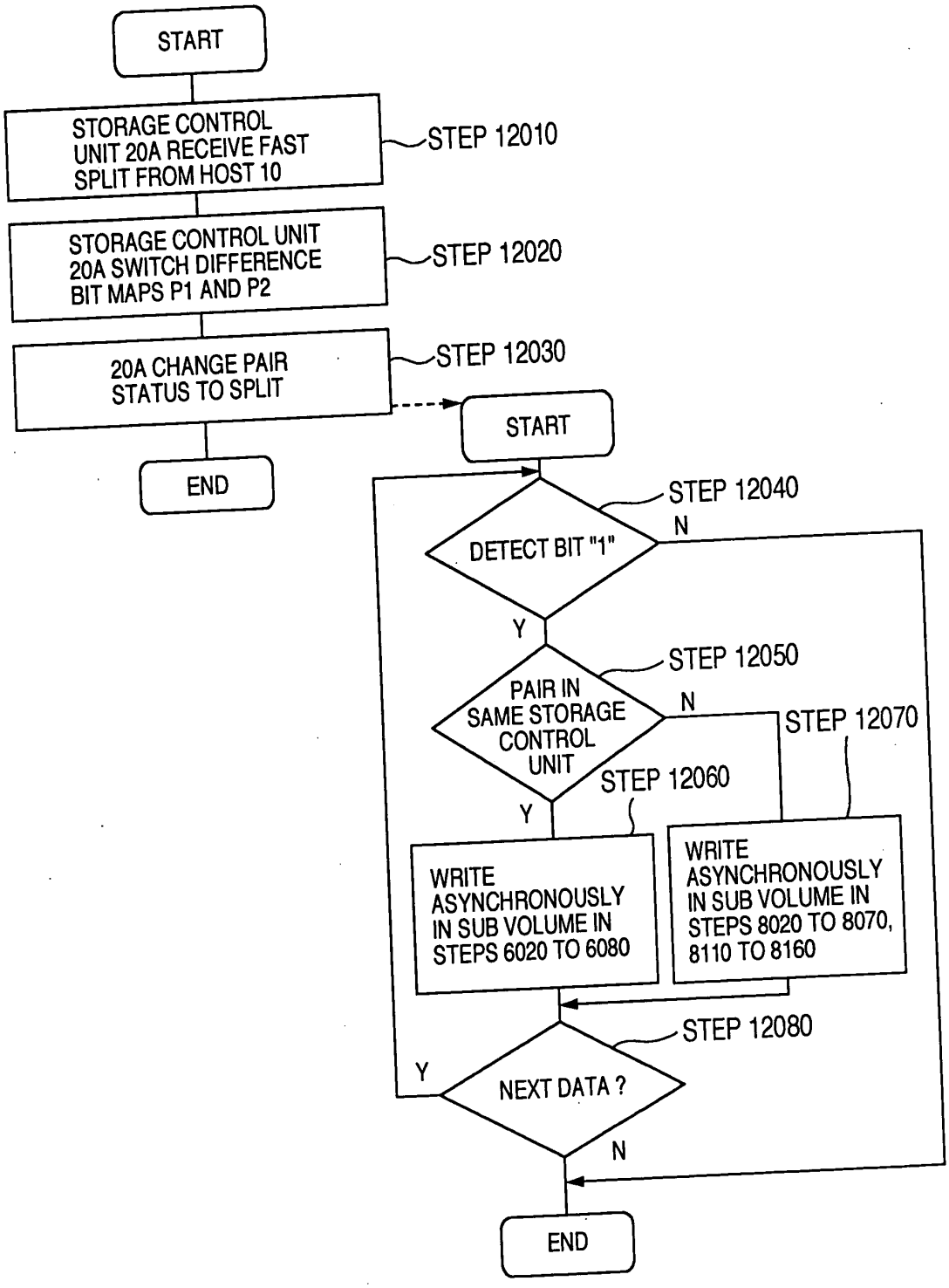

START
STORAGE CONTROL UNIT 20A RECEIVE FAST SPLIT FROM HOST 10
STEP 12010
STORAGE CONTROL UNIT 20A SWITCH DIFFERENCE BIT MAPS P1 AND P2
STEP 12020
20A CHANGE PAIR STATUS TO SPLIT
STEP 12030
END
START
STEP 12040
DETECT BIT "1"
N
Y
STEP 12050
PAIR IN SAME STORAGE CONTROL UNIT
N
STEP 12070
Y
STEP 12060
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 6020 TO 6080
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 8020 TO 8070, 8110 TO 8160
STEP 12080
Y
NEXT DATA ?
N
END

FIG.13

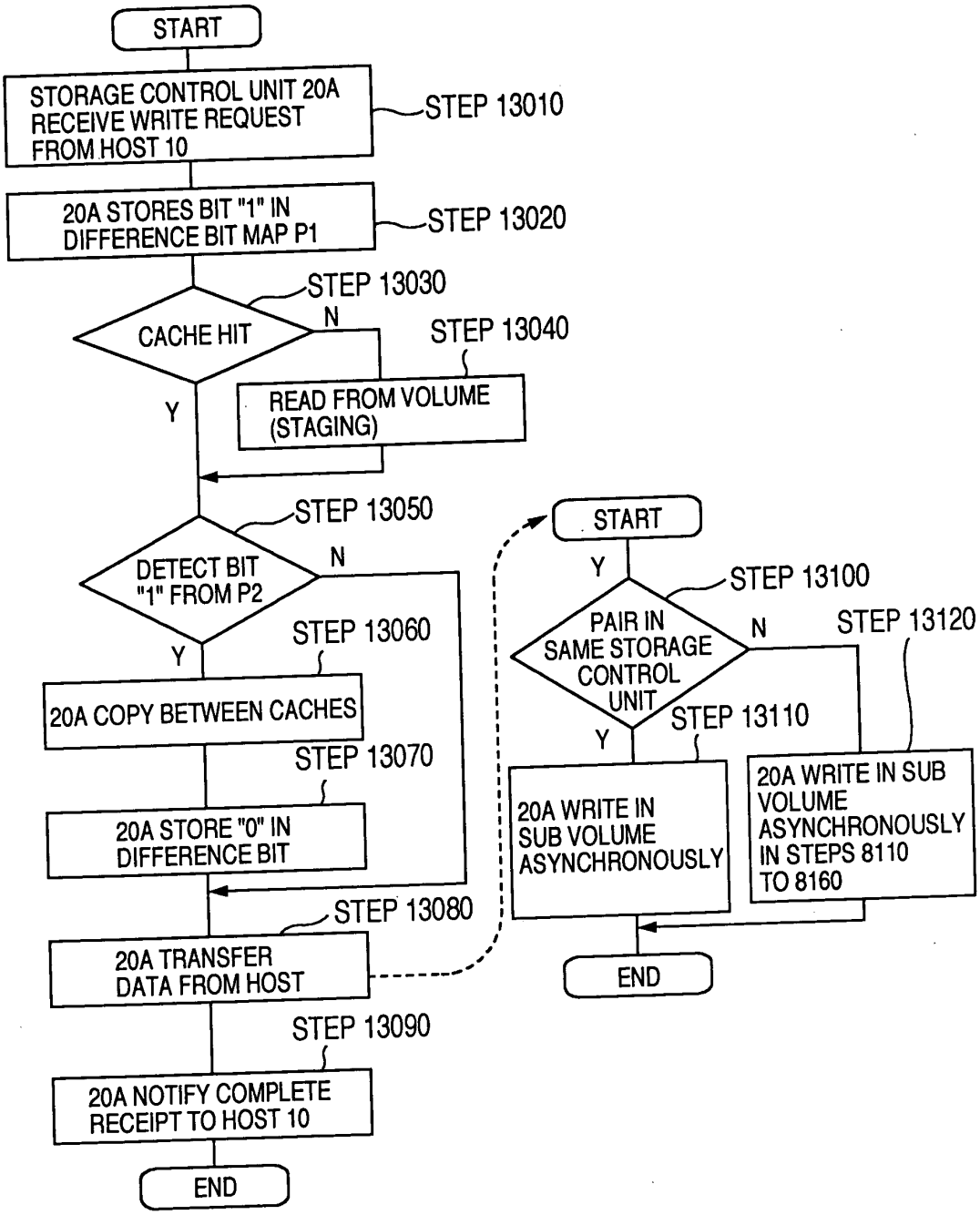
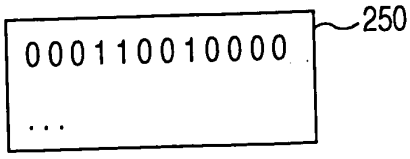


FIG.14



JOB PRIORITY INFORMATION BIT MAP

FIG.15

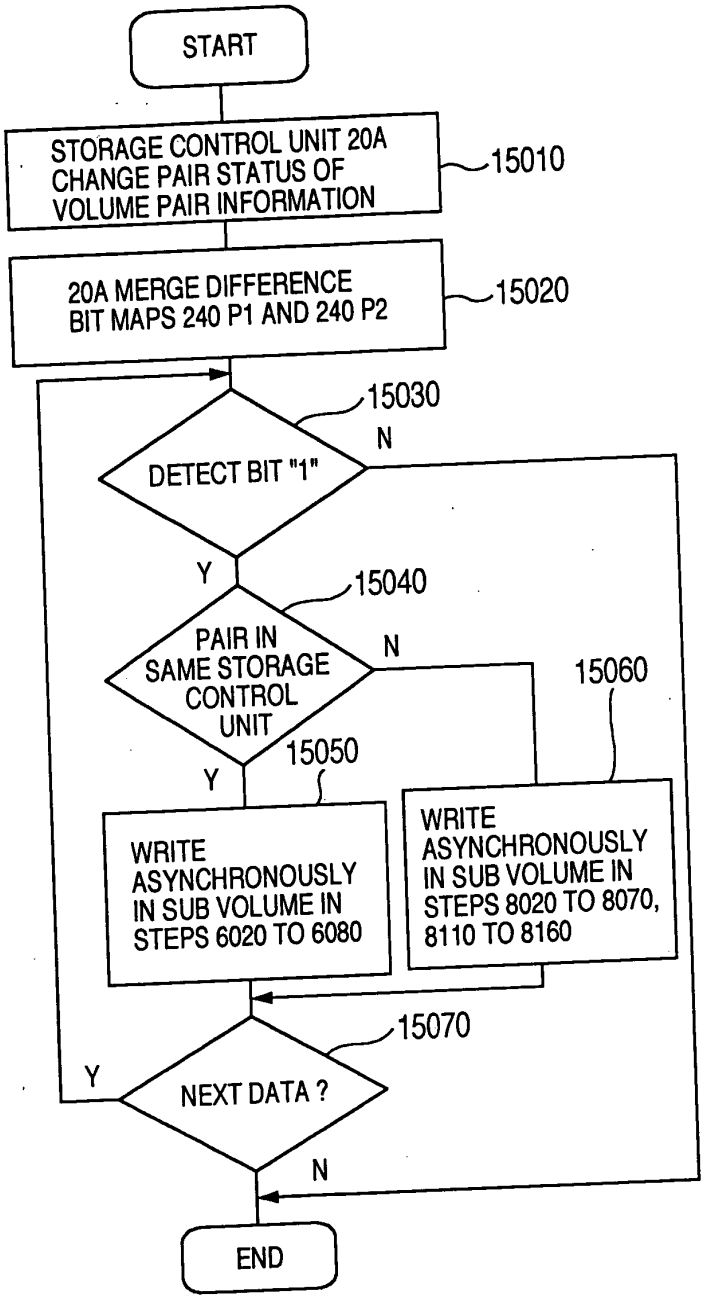

START
STORAGE CONTROL UNIT 20A CHANGE PAIR STATUS OF VOLUME PAIR INFORMATION
15010
20A MERGE DIFFERENCE BIT MAPS 240 P1 AND 240 P2
15020
15030
DETECT BIT "1"
N
Y
15040
PAIR IN SAME STORAGE CONTROL UNIT
N
15060
Y
15050
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 6020 TO 6080
WRITE ASYNCHRONOUSLY IN SUB VOLUME IN STEPS 8020 TO 8070, 8110 TO 8160
15070
Y
NEXT DATA ?
N
END

FIG.16

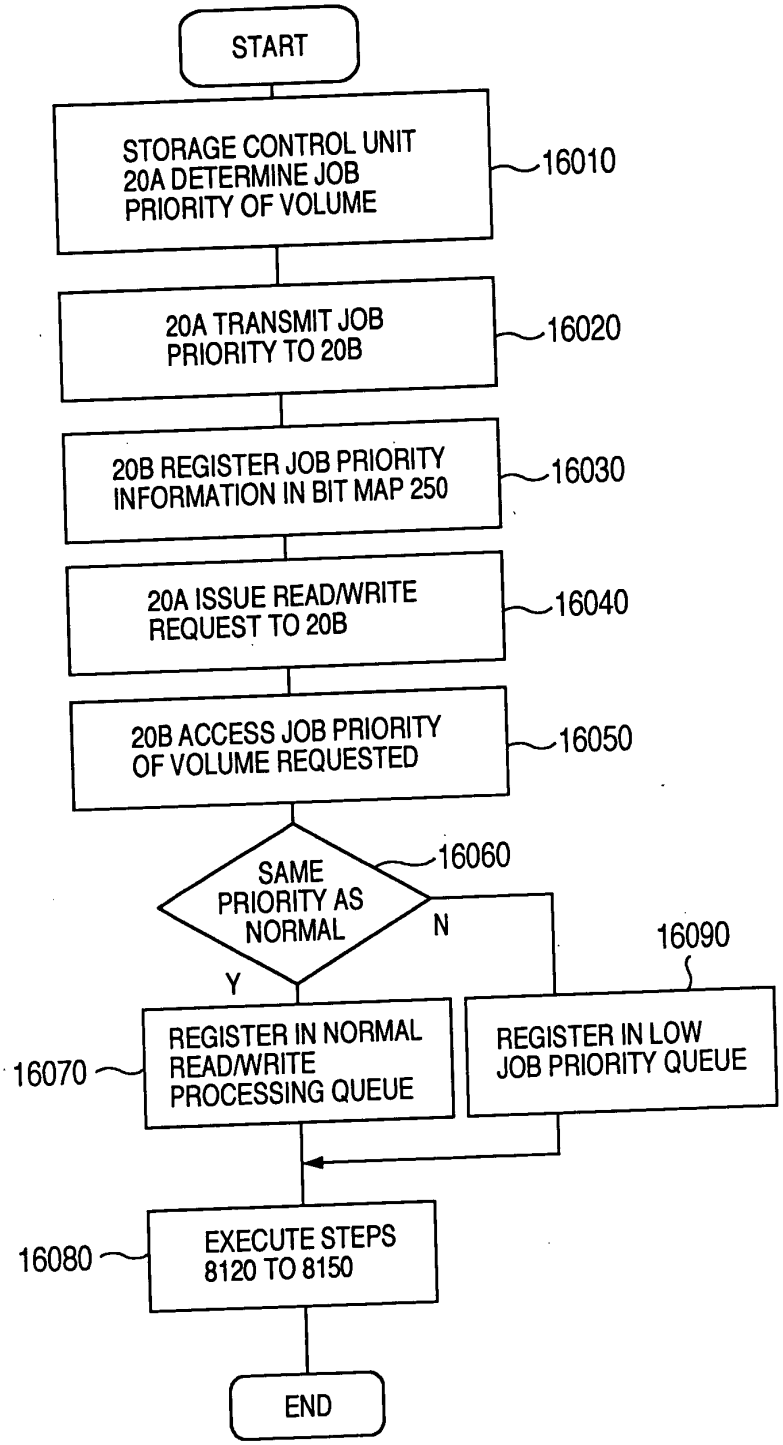

START
STORAGE CONTROL UNIT 20A DETERMINE JOB PRIORITY OF VOLUME
16010
20A TRANSMIT JOB PRIORITY TO 20B
16020
20B REGISTER JOB PRIORITY INFORMATION IN BIT MAP 250
16030
20A ISSUE READ/WRITE REQUEST TO 20B
16040
20B ACCESS JOB PRIORITY OF VOLUME REQUESTED
16050
SAME PRIORITY AS NORMAL
16060
N
Y
16090
REGISTER IN NORMAL READ/WRITE PROCESSING QUEUE
16070
REGISTER IN LOW JOB PRIORITY QUEUE
EXECUTE STEPS 8120 TO 8150
16080
END

FIG.17

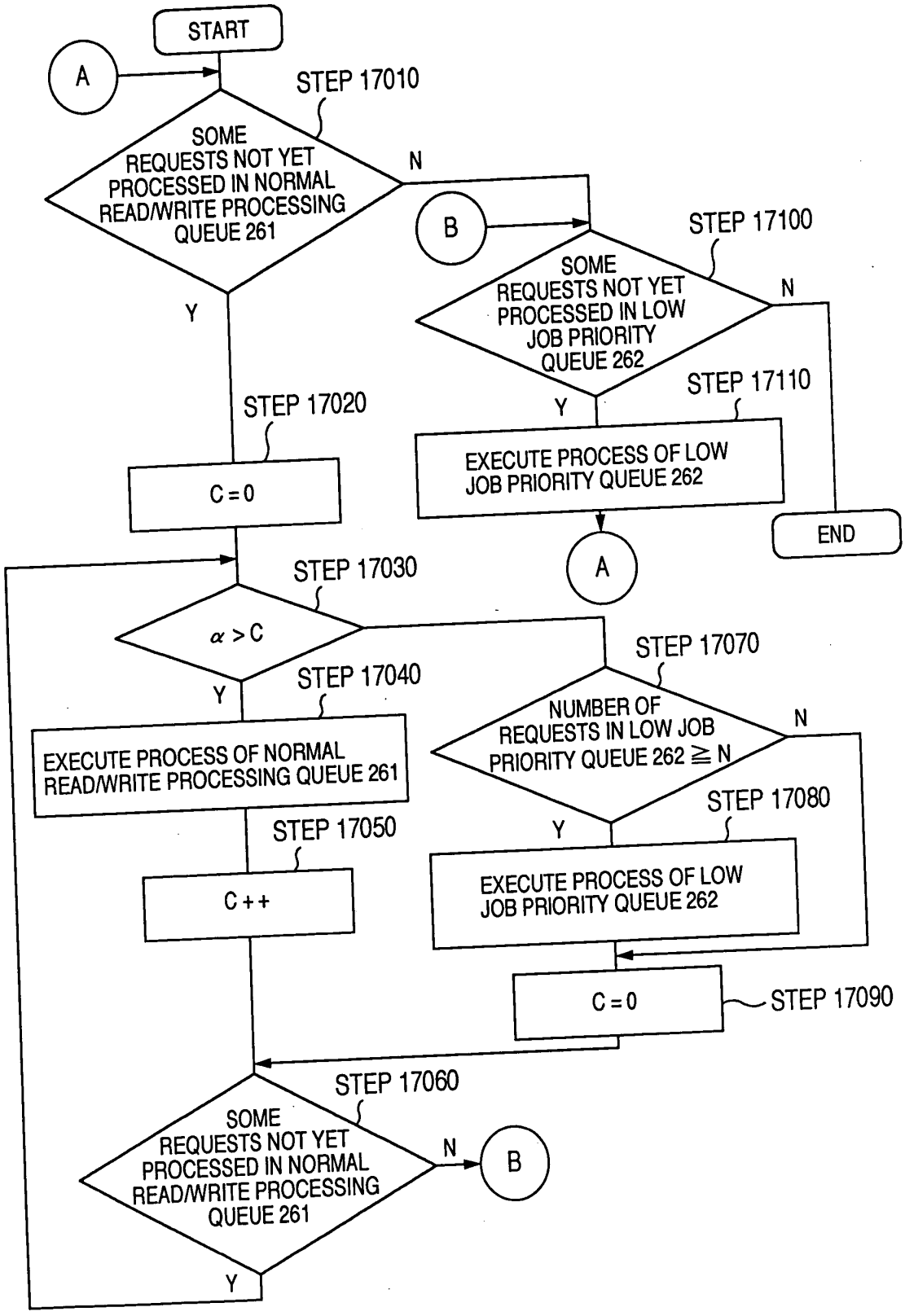
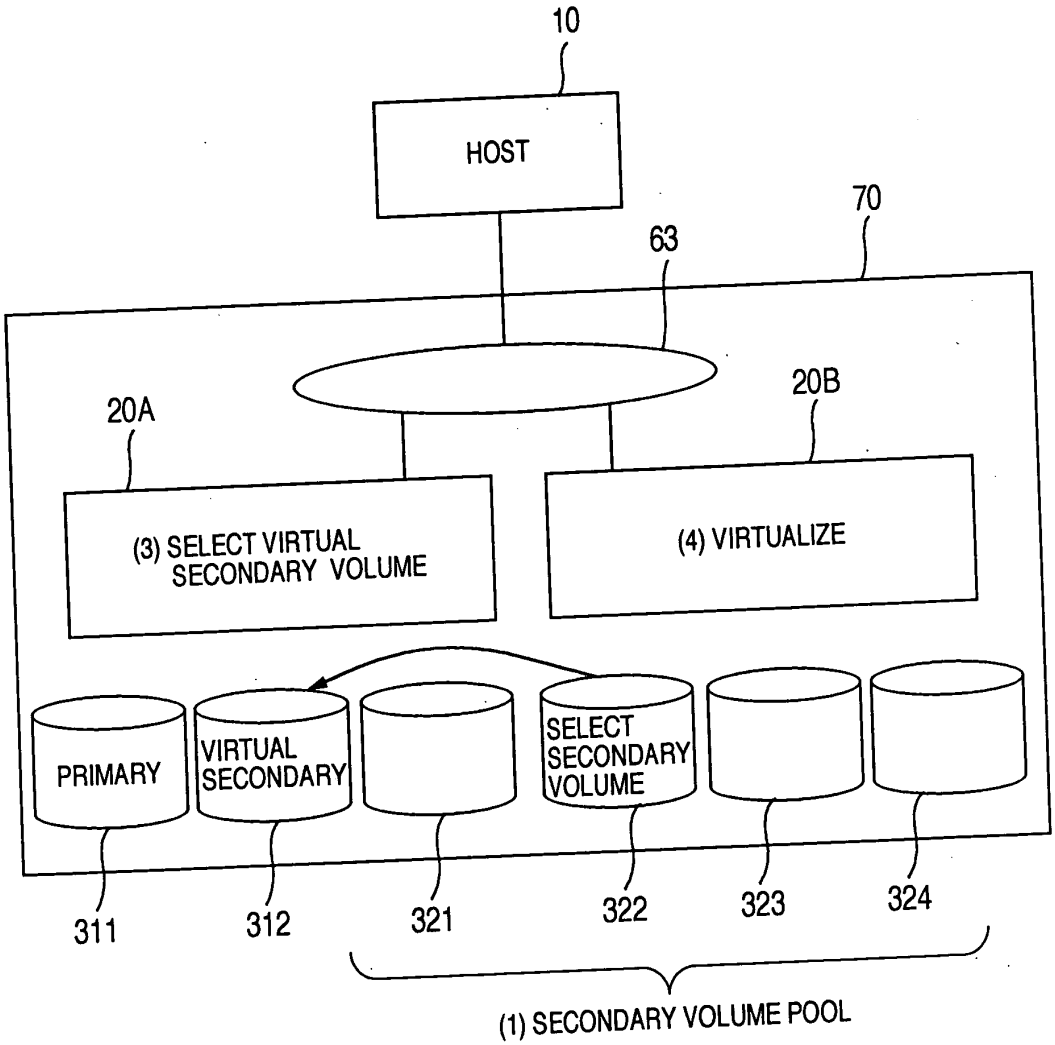

START
A
STEP 17010
SOME REQUESTS NOT YET PROCESSED IN NORMAL READ/WRITE PROCESSING QUEUE 261
N
Y
B
STEP 17100
SOME REQUESTS NOT YET PROCESSED IN LOW JOB PRIORITY QUEUE 262
N
Y
STEP 17110
EXECUTE PROCESS OF LOW JOB PRIORITY QUEUE 262
END
A
STEP 17020
C = 0
STEP 17030
α > C
Y
STEP 17040
EXECUTE PROCESS OF NORMAL READ/WRITE PROCESSING QUEUE 261
STEP 17050
C++
STEP 17070
NUMBER OF REQUESTS IN LOW JOB PRIORITY QUEUE 262 ≧ N
N
Y
STEP 17080
EXECUTE PROCESS OF LOW JOB PRIORITY QUEUE 262
C = 0
STEP 17090
STEP 17060
SOME REQUESTS NOT YET PROCESSED IN NORMAL READ/WRITE PROCESSING QUEUE 261
N
B
Y

FIG.18


10
HOST
70
63
20A
20B
(3) SELECT VIRTUAL SECONDARY VOLUME
(4) VIRTUALIZE
PRIMARY
VIRTUAL SECONDARY
SELECT SECONDARY VOLUME
311
312
321
322
323
324
(1) SECONDARY VOLUME POOL